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## Gas cylinders — Composite cylinders and tubes — Periodic inspection and testing

*Bouteilles à gaz — Bouteilles et tubes composites — Contrôles et essais périodiques*

ICS: 23.020.35

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CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 4, *Operational requirements for gas cylinders*.

This third edition cancels and replaces the second edition (ISO 11623:2015), which has been technically revised.

The main changes are as follows:

- revised scope to include cylinders and tubes with a water capacity up to 3 000 l;
- modification of [Table 1](#) to separate abrasion damage based on water capacity of the cylinder;
- clarification that a transparent sleeve may be left in place during inspection ([7.1.3](#)); and
- clarification on the use of tare during inspection.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

The principal aim of periodic inspection and testing is that at the completion of the test, the cylinders can be reintroduced into service. It is not possible to identify all considerations for periodic inspection and testing of composite cylinders in this document. In such cases or where there is doubt, questions regarding specific cylinders should be directed to the manufacturer or owner.

This document is intended to be used under a variety of national regulatory regimes but has been written so that it is suitable for the application of the UN *Model Regulations*<sup>[1]</sup>.

This document also gives other requirements concerning preparation, finishing and maintenance of composite cylinders and tubes as well as the safety precautions for the personnel performing this work. These requirements can be mandatory under other regulations.

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# Gas cylinders — Composite cylinders and tubes — Periodic inspection and testing

**CAUTION** — Some of the tests specified in this document involve the use of processes that could lead to a hazardous situation.

## 1 Scope

This document specifies the requirements for periodic inspection and testing and to verify the integrity for further service of hoop-wrapped and fully wrapped composite transportable gas cylinders and tubes, with aluminium-alloy, steel or non-metallic liners or of linerless construction (Types 2, 3, 4, and 5), intended for compressed, liquefied or dissolved gases under pressure, of water capacity from 0,5 l up to 3 000 l.

This document is written to address the periodic inspection and testing of composite cylinders and tubes constructed to ISO 11119-1, ISO 11119-2, ISO 11119-3, ISO 11119-4 and ISO 11515 standards and can be applied to other composite cylinders and tubes designed to comparable standards when authorized by the competent authority.

As far as practicable, this document also can be applied to cylinders of less than 0,5 l water capacity when authorized by the manufacturer.

**NOTE** Unless noted by exception, the use of the word “cylinder” in this document refers to both cylinders and tubes.

## 2 Normative references

[ISO/EDIS 11623](#)

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The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10286, *Gas cylinders — Vocabulary*

ISO 11114-2, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 2: Non-metallic materials*

ISO 11621, *Gas cylinders — Procedures for change of gas service*

ISO 13341, *Gas cylinders — Fitting of valves to gas cylinders*

ISO 13769, *Gas cylinders — Stamp marking*

ISO 18119, *Gas cylinders — Seamless steel and seamless aluminium-alloy gas cylinders and tubes — Periodic inspection and testing*

ISO 22434, *Gas cylinders — Inspection and maintenance of valves*

ISO 25760, *Gas cylinders — Operational procedures for the safe removal of valves from gas cylinders*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10286 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

### 3.1

#### **composite overwrap**

combination of *fibres* (3.3) (including steel wire) and *matrix* (3.15)

### 3.2

#### **external coating**

layer of material applied to the cylinder as a protective coating not intended to be removed or for cosmetic purposes

EXAMPLE Gel coat and paint.

Note 1 to entry: Not all composite cylinders will have a special external coating.

### 3.3

#### **fibre**

load-carrying part of the *composite overwrap* (3.1)

EXAMPLE Glass, aramid or carbon

### 3.4

#### **type 5 cylinder**

fully wrapped cylinder without a liner and with composite reinforcement on both the cylindrical portion and dome ends

### 3.5

#### **type 4 cylinder**

fully wrapped cylinder with a non-load sharing *liner* (3.11) and composite reinforcement on both the cylindrical portion and the dome ends

### 3.6

#### **type 3 cylinder**

fully wrapped cylinder with a load sharing metal *liner* (3.11) and composite reinforcement on both the cylindrical portion and the dome ends

### 3.7

#### **type 2 cylinder**

hoop wrapped cylinder with a load-sharing metal *liner* (3.11) and composite reinforcement on the cylindrical portion only

### 3.8

#### **translucent cylinder**

cylinder that permits the passage of light

### 3.9

#### **identification label**

label containing the permanent markings required by the relevant design specification

### 3.10

#### **design life**

maximum life (in number of years) to which a composite cylinder or tube is designed and approved in accordance with the applicable standard

### 3.11

#### **liner**

inner portion of a composite cylinder, comprising a metallic or non-metallic vessel, whose purpose is both to contain the gas and transmit the gas pressure to the *composite overwrap* (3.1)

### 3.12

#### **non-metallic liner**

*liner* (3.11) made from thermoplastic, thermosetting, or elastomeric material



**3.13****sleeve**

transparent or non-transparent cover fitted to the outside surface of the cylinder

**3.14****repair**

set of activities performed on defective pressure equipment to restore its compliance with the relevant specification

Note 1 to entry: Repair can include replacing worn or damaged parts meeting the original specification

**3.15****matrix**

material that is used to bind and hold the *fibres* (3.3) in place

Note 1 to entry: The matrix is sometimes called resin.

**3.16****rejected cylinder**

cylinder not fit for service or which needs to be set aside for further evaluation or testing in its present condition

**3.17****bulge**

visible swelling of the wall

Note 1 to entry: A bulge is away from the centreline (convex) and a dent is towards this centreline (concave).

**3.18****crack**

split or separation in the material, typically appearing as a line on the surface

**3.19****crease**

off-colour linear or non-linear feature formed as a result of previous localized over-stressing

**3.20****protective attachment**

component connected to the cylinder that prevents or resists damage to the composite cylinder

EXAMPLE Casing.

Note 1 to entry: Some protective attachments are designed to be removed at the time of periodic inspection and testing.

**3.21****permanent protective attachment**

integral part of the cylinder design permanently affixed to composite cylinders (Types 2 to 5) covering part of or the entire surface of the cylinder, providing additional functions during handling, transport and use

**3.22****stoving**

treat by heating (e.g. in an oven) in order to apply a desired surface coating

## 4 Due dates for periodic inspection and testing

A cylinder shall be due for periodic inspection and testing on its first receipt by a filler following the expiry of the interval established in accordance with the requirements of national or international regulations or, in the absence of regulations, in accordance with the UN *Model Regulations*<sup>[1]</sup>.

NOTE [Annex A](#) provides guidance regarding the intervals between periodic inspection and testing.

The expiry date is based on the last test date shown on the cylinder. Other means of indicating the expiry date are permitted.

Provided the cylinder has not been subjected to abusive and abnormal conditions such as being involved in an accident, heat exposure or other severe conditions that would render it unsafe, there is no requirement for the user to return a cylinder before the contents have been used even though the periodic inspection and testing interval has lapsed.

When the design life has expired, the cylinder shall not be refilled and shall be removed from service when presented for the next filling (see [Clause 13](#)).

In some jurisdictions, it is the responsibility of the owner or user to submit cylinders used for emergency purposes for periodic inspection and testing within the specified interval.

## 5 Procedures for periodic inspection and testing

### 5.1 List of procedures

The inspection, testing and repair of composite cylinders shall be carried out only by competent persons in suitable facilities for cylinders of the size and type being requalified. Care shall be taken to ensure that during the retest procedure, cylinders are handled carefully, particularly with respect to loading. When moving from handling pallets or other transport frames, processes shall be developed to ensure cylinders are not dropped or impacted during movement. Special handling methods and tooling may be required to safely handle cylinders.

Handling procedures shall be available at the authorized inspection site.

Tests and examinations performed to demonstrate compliance shall be conducted using instruments calibrated before being put into service and thereafter according to an established programme.

Each cylinder shall be submitted to periodic inspection and testing. The following procedures form the requirements for this periodic inspection and testing and are explained more fully in this document in the noted clauses:

- identification of cylinder and preparation for periodic inspection and testing (see [Clause 6](#));
- external visual inspection (see [Clause 7](#));
- safe removal of valve (see [8.1](#));
- internal visual inspection and cleaning (see [8.2](#));
- pressure test (see [Clause 9](#));
- leak test (see [Clause 10](#));
- inspection of valve (see [Clause 11](#));
- final operations (see [Clause 12](#)); and
- rejection and rendering cylinders unserviceable (see [Clause 13](#)).

The external and internal visual examination (see [Clauses 7](#) and [8](#)) shall be carried out prior to the pressure test (see [Clause 9](#)). It is recommended that the other tests are performed in the sequence listed above; for the safe removal of a valve, the requirements in ISO 25760 shall be met.

Cylinders that fail inspection or testing shall be rejected (see [Clause 13](#)). When a cylinder passes the above-listed procedures but the condition of the cylinder remains in doubt, additional testing shall be performed to confirm its suitability for continued service or the cylinder shall be rendered unserviceable. Depending on the reason for the rejection, cylinders may be recovered and/or repaired (see [7.4](#)).

## 5.2 Heat exposure

When cylinders are refurbished during periodic inspection, it might be necessary to expose them to heat, for example, during initial cleaning, or as part of a stoving operation when painting or powder coating the cylinder. This heat exposure can affect the mechanical properties of the liners and/or the finished composite cylinder.

It is therefore essential that information on precise heat-effect temperatures from the cylinder manufacturer be available; in the absence of this information, cylinders shall not be exposed to a temperature exceeding 70 °C during refurbishment. If the cylinder manufacturer confirms (i.e. either on a cylinder label or through documentation) that the allowable temperature is greater than 70 °C, then the manufacturer's recommendations shall be followed during refurbishment.

## 6 Identification of cylinder and preparation for periodic inspection and testing

Before any work is carried out, the relevant cylinder marks (e.g. see ISO 13769) and the gas contents (e.g. see ISO 7225) shall be identified. First, the marking shall be checked to ensure that the cylinder in question is within its design life. When composite cylinders have been designed and manufactured for a limited design life, this is indicated on the cylinder marking.

The cylinder shall be depressurized and emptied in a safe, controlled manner before proceeding. For Type 4 and Type 5 cylinders, take necessary precautions and/or consult the cylinder manufacturer for depressurization procedures to avoid damaging the cylinder.

**WARNING — The uncontrolled opening and/or removal of valves from cylinders can lead to injury, death and/or property damage.**

Prior to valve removal, the user shall follow procedures described in ISO 25760. A verification shall be made to ensure that the cylinder is empty of gas. Provided the requirements as stated in ISO 25760 have been complied with, the cylinder shall be depressurized safely and the valve removed.

Cylinders with unknown gas contents shall be emptied as if the gas is dangerous (i.e. toxic, flammable or oxidizing) as described in ISO 25760.

When the valve is non-functional, cylinders shall be emptied safely as described in ISO 25760.

Access shall be provided to the entire external surface of the cylinder for visual inspection and measurement.

## 7 External visual inspection

### 7.1 Preparation

#### 7.1.1 General

The composite material including any external coating applied for protection shall not be removed for the visual inspection.

Composite cylinders differ from their metal counterparts in that a competent person may repair them when only limited damage has taken place (see 7.4). These limits are specified in Table 1; following this repair, cylinders shall be subjected to a pressure test before being returned to service.

If the cylinder identification label is illegible, the manufacturer shall be contacted or the cylinder shall be rejected in accordance with Clause 13.

The manufacturer may provide a supplementary identification label to the cylinder if, as a minimum, the original label's serial number is still clearly legible.

When the cylinder manufacturer provides acceptance/rejection criteria for external damage, it takes precedence over the criteria specified in Table 1.

### 7.1.2 Permanent protective attachments

Permanent protective attachments of the composite cylinder shall not be removed prior to inspection, provided that these attachments are part of the original design. The manufacturer shall provide acceptance/rejection criteria to be applied during the visual inspection for any damage to the permanent protective attachments.

Markings specific to permanent attachments on the cylinder shall indicate if the attachments shall remain in place at the time of the periodic inspection and testing. If such markings are not present, the cylinder manufacturer shall be consulted to establish whether the permanent attachments need to be removed.

### 7.1.3 Sleeves

When a transparent sleeve is used, it may be left in place as long as the composite wrapping can be inspected effectively without its removal.

When a non-transparent sleeve is used that is not part of the cylinder design, it shall be removed prior to inspection.

When the cylinder is suspected to be damaged, or if there are concerns regarding the operating environment of the cylinder, e.g. saline atmosphere, the transparent sleeve shall be removed, and an inspection of the composite material undertaken.

### 7.1.4 Cleaning

Care shall be taken not to remove any evidence of in-service damage (e.g. heat and fire damage), which could affect the outcome of this inspection (see Table 1).

Each cylinder shall be cleaned and have all loose foreign matter removed from its external surface by a suitable method (e.g. washing, light brushing, controlled water jet cleaning, plastic bead blasting).

Grit and shot blasting are not suitable. Chemical cleaning agents, paint strippers and solvents shall not be used unless it has been established that they would not have an adverse effect on the cylinder or its materials.

Care shall be taken to ensure the legibility of the identification marks when undertaking a cleaning operation.

## 7.2 Inspection procedures

The cylinder manufacturer shall determine the acceptance/rejection criteria for external damage, which takes precedence over the criteria outlined in Table 1.

The acceptance/rejection criteria are given in Table 1 to be followed in the absence of specific instructions from the manufacturer of the cylinder being examined. The external metallic surface of hoop wrapped cylinders shall be visually inspected in accordance with the applicable clauses of the

relevant standard (i.e. ISO 18119). Particular attention shall be paid to the interface with the composite overwrap.

The external surface shall be inspected for damage to the composite overwrap. There are three levels of damage that shall be considered (see [7.3.3](#)); of these, only level 2 can be repaired (see [Table 1](#)).

## 7.3 Damage

### 7.3.1 General

Damage to the composite overwrap can appear in many forms, and examples of these are described in [7.3.3](#). The acceptance/rejection criteria are specified in [Table 1](#), which refers to specified damage levels and the types of damage. Care shall be taken to establish the total extent of damage from impact (see [7.3.4.3](#)) and delamination (see [7.3.4.4](#)) as surface appearance might not indicate the full extent of the damage.

[Annex B](#) specifies additional damage criteria for steel wire wound, aluminium-alloy cylinders.

When damage is caused by installation (e.g. trailer or bundle), severity or conditions of service, or by improper cylinder use, the inspector should advise the cylinder owner of the need to take corrective action to prevent or reduce further cylinder damage, or to prevent damage to a replacement cylinder. Such actions should be developed with the manufacturer of the cylinder and the original installer.

### 7.3.2 Damage levels

#### 7.3.2.1 General

The surface of the cylinder shall be inspected for evidence of damage. Damage shall be evaluated in accordance with [Table 1](#). In the absence of acceptance criteria for damage not specified in this standard, such damage shall be identified as Level 3 damage unless it is demonstrated by additional testing that the cylinder is safe for continued service.

#### 7.3.2.2 Level 1 damage

Cylinders with minor or superficial damage are categorized as having Level 1 damage. Such damage has no adverse effects on the safety of the cylinder and its continued use. These cylinders may be returned to service with no repair.

Scratched paint or nicks that have no appreciable depth in metal, or similar damage in the composite cylinder paint or resin where there are no visible frayed fibres, are considered to be of this level of damage.

#### 7.3.2.3 Level 2 damage

Level 2 damage is rejectable damage that requires repair, testing, or rendering the cylinder unserviceable, as advised by the cylinder manufacturer. Level 2 damage is also reserved for conditions specified by the manufacturer, which can differ from Level 1 or Level 3 damage outlined in [Table 1](#).

#### 7.3.2.4 Level 3 damage

Level 3 damage is sufficiently severe that the cylinder shall not be repaired but shall be rejected and subsequently rendered unserviceable.